## REMARKS

Claims 1-9 are pending in the application. Claims 1-3 are withdrawn from consideration. Claims 4 and 5 are amended herein to be in the product-by-process format, i.e., to include the subject matter of claim 1.

No new matter has been added by way of the present submission.

In view of the following remarks, the Examiner is respectfully requested to withdraw all rejections and allow the currently pending claims.

### *July 10, 2008 Telephone Interview*

Applicants note with appreciation that the Examiner has conducted a telephone Interview with Applicants' representative, Paul Pyla. The Examiner clarified the rejection under 35 U.S.C. § 112, second paragraph and confirmed that only claims 4 and 5 are rejected over Masayuki et al. (JP 2000-306568). Further details of the telephone Interview are provided below.

### *Rejection Under 35 U.S.C. § 112, Second Paragraph, Indefiniteness*

Claims 4-9 stand rejected under 35 U.S.C. § 112, second paragraph, for allegedly being indefinite for failing to particularly point out and distinctly claim the subject matter which Applicants regard as the invention. Applicants respectfully traverse the rejection.

According to the Examiner, the presently amended claims recite Gurley permeability without setting forth differences in the pore size and porosity inside the film and at the surface of the film which renders claims vague and indefinite. As the Examiner indicates, it appears that Applicant's claim is incomplete and it raises issue of indefiniteness.

During the July 10, 2008 telephone Interview the Examiner clarified this rejection. The Examiner stated that the claims were rejected as indefinite since the ratio of the average surface pore size (A) to average inside pore side (B) (A/B) includes within its range the value of 1, the claim language is broad enough to read on the homogeneous structure of the porous film of the

previously applied reference of Shigeru et al., JP 2002-086476 (hereinafter "Shigeru" – attached hereto is a machine English translation thereof).

According to the Examiner since the A/B ratio can include a film such as the film in Shigeru (which appears to have the same structure and composition of the present invention), it appears that a process step, structure or key element is missing from the claims that adds to the present invention the improved Gurley permeability. The Examiner acknowledges that Shigeru was overcome as prior art with the Gurley permeability limitation, but the claims are missing a feature or element that indicates this difference.

In response, Applicants have amended claims 4 and 5 to be in the product-by-process format. Specifically, claims 4 and 5 have been amended to recite that the porous film

> is produced in a method comprising the steps of casting a polymer solution comprising a polymer onto a substrate to form a film; and subjecting the film to phase conversion to thereby form a porous film, wherein the polymer constituting the porous film has a surface tension Sa [mN/m], wherein the substrate has a surface tension Sb [mN/m], and wherein Sa and Sb satisfy the following condition: $Sa-Sb \geq -10$.

As discussed in great detail below, these method steps would give the inventive porous film a structure which is distinct from the porous film of Shigeru and gives the inventive porous film an improved Gurley permeability. As such, withdrawal of the rejection is respectfully requested.

***Issues Under 35 U.S.C. § 102/103(a), Anticipation/Obviousness***

The Examiner has issued the following Rejections:

(A) Claims 4-9 are rejected under 35 U.S.C. § 102(a) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Michio, JP 2003-313356 (hereinafter "Michio");

(B) <u>Claims 4-9</u> are rejected under 35 U.S.C. § 102(b) as anticipated by or, in the alternative, under 35 U.S.C. 103(a) as obvious over Patel *et al.*, U.S. Patent Application Publication No. 2001/0023014A1 (hereinafter "Patel"); and

(C) <u>Claims 4 and 5</u> are rejected under 35 U.S.C. 103(a) as being unpatentable over Masayuki *et al.*, JP 2000-306568 (hereinafter "Masayuki").

Applicants respectfully traverse Rejections (A)-(C).

With respect to Rejection (A), Applicants respectfully submit that Michio is not prior art since it has a publication date of November 6, 2003, while the effective US filing date for the present application is August 19, 2003. Thus, it appears that Rejection (A) is rendered moot.

With respect to Rejection (B), the following comments are respectfully submitted.

The film of the present invention is produced by the presently claimed method including the steps of casting a polymer solution having a polymer onto a substrate to form a film and subjecting the film to phase conversion to thereby form a porous film which satisfies the following condition: $Sa\text{-}Sb \geq -10$, wherein Sb [mN/m] is the surface tension of the substrate and wherein Sa is the surface tension of the polymer constituting the porous film.

According to this method, the film has uniform micropores as a whole, i.e., in the surface of the film which had not been in contact with the substrate upon casting, inside the film, and **in particular, in the surface which had been in contact with the substrate upon casting.**

In the thus produced present film having uniform micropores as a whole, high Gurley permeability such as 0.2 to 29 seconds per 100cc is obtained. This is best seen by viewing the Examples of the present invention.

**In the present example 1,** the composition comprising the amide-imide polymer having a measured surface tension as the polymer alone of **42 mN/m** (=dyn/cm) was cast onto a Teflon substrate having a surface tension of **24 mN/m** (=dyn/cm). As such, the Sa-Sb=18 mN/m. The film was formed having the following characteristics:

(a) the surface which had been in contact with the substrate upon casting (substrate-side surface of the film) containing pores having ***an average pore size $A^1$ of about 0.9 μm, a maximum pore size of 2.5 μm and an average rate of hole area $C^1$ of about 65%***;

(b) another surface of the film which had not been in contact with the substrate upon casting (air-side surface of the film) containing pores having ***an average pore size $A^2$ of about 1.1 μm, a maximum pore size of 2.7 μm and an average rate of hole area $C^2$ of about 70%***; and

(c) the inside of the film was substantially homogenous and entirely contained continuous micropores having an average pore size B of about 1.0 μm and a maximum pore size of about 1.8 μm with an average rate of inner hole area D of 70%.

Furthermore, the permeation capability of this film was determined to find that the film had superior permeation capabilities in terms of **a Gurley permeability of 9.5 seconds** and a pure-water permeation rate of $9.8\times10^{-9}$ m•sec$^{-1}$•Pa$^{-1}$ [=60 liter/(m$^2$•min•atm at 25°C)].

**In the comparative example 1,** the film was prepared by the procedure of Example 1, except for using a glass substrate having a surface tension of **100 mN/m** (=dyn/cm) as a substrate for casting instead of the Teflon (registered trademark) substrate. As such, the Sa-Sb=-58 mN/m. The film was formed having the following characteristics:

(a) the substrate-side surface of the film containing pores having ***an average pore size $A^1$ of about 0.3 μm, a maximum pore size of 0.6 μm and an average rate of hole area $C^1$ of about 40%***;

(b) the air-side surface of the film contained pores having ***an average pore size $A^2$ of about 1.0 μm, a maximum pore size of 2.5 μm and an average rate of hole area $C^2$ of about 70%***; and

(c) the inside of the film was substantially homogenous and entirely contained continuous micropores having an average pore size B of about 1.0 μm and a maximum pore size of about 2.0 μm with an average rate of inner hole area D of about 70%.

The film has micropores at the substrate-side surface thereof having dimensions and a rate of hole area smaller than those of micropores at the air-side surface and inside the film, and that **the film as a whole lacks uniformity**.

As the Examiner stated in the Office Action, on the present film, the ratio of A/B, C/D, $A^1/A^2$, and $C^1/C^2$ includes 1 and a homogeneous porous film with respect to porosity and pore size is contemplated, and the homogeneous porous film obtained by the present method is further uniform as a whole, **in particular, in the surface which had been in contact with the substrate upon casting,** and, therefore, has a high Gurley permeability of 0.2 to 29 seconds per 100cc.

On the other hand, Shigeru, Petel, and Masayuki do not teach the use of a substrate having a surface tension Sb [mN/m] satisfying the following condition: Sa-Sb≥-10, where Sa is a surface tension of the polymer constituting the porous film. Thus, homogeneous porous films by Shigeru, Petel, and Masayuki would not be uniform as a whole, in particular, in the surfaces which had been in contact with the substrate upon casting, and, therefore, they do not have such a high Gurley permeability, as presently claimed.

Certain polymeric compounds such as amide-imide polymers, imide polymers, sulfone polymers, fluorocarbon polymers and olefin polymers are known as materials for constituting porous films. Porous films are produced from these materials, for example, by a phase conversion technique in which a mixture containing the polymeric compound is cast as a film and the film is brought to a solidifying liquid. The resulting film produced by the phase conversion technique using the polymeric compound as a material, however, has a skin layer (compact layer) on its surface and contains substantially no hole area (opening) or contains some openings with a low rate of hole area (see page 1, line 18 to page 2, line 4 of the present specification).

After intensive investigations to achieve the objectives, the present inventors have found that a porous film having homogenous micropores with a high rate of hole area even on a surface of the film which has been in contact with a substrate can be prepared by casting a solution mixture containing a polymer onto a substrate to form a film and subjecting the film to phase conversion, in which the difference in surface tension between the polymer and the substrate is at a specific level or more. The present invention has been achieved based on these findings.

Specifically, the present invention provides a method for producing a porous film, including the steps of casting a polymer solution containing at least one polymer onto a substrate to form a film; and subjecting the film to phase conversion to thereby form a porous film, in which the polymer constituting the porous film has a surface tension Sa [mN/m], the substrate has a surface tension Sb [mN/m], and Sa and Sb satisfy the following condition: $Sa-Sb \geq -10$ (page 2, line 21 to page 3, line 13 in the present specification).

If the substrate is a composite plate comprising a surface layer and a core comprising different materials from each other, only the material to form a contact surface with the polymer has to have a surface tension satisfying the requirement. **If the difference (Sa-Sb) is less than -10, the resulting film has a low rate of surface hole area and cannot be practically used, since the polymer coagulates at the interface between the polymer and the substrate to thereby form a compact phase.**

By using such a polymer and a substrate satisfying the above-specified condition, the solution mixture containing the polymer undergoes phase separation to form **an islands-in-sea structure on the substrate**, which results in micropores of the resulting film. This specifically yields a porous film having a high rate of hole area especially at a surface which has been in contact with the substrate (page 6, line 14 to page 7, line 10 in the present specification).

Shigeru teaches in paragraph 0041 that a porous film having the pore size of 0.01 to 10 micrometers and porosity of 15 to 85%, however, Shigeru does not teach a film which is uniform as a whole, in particular, in the surfaces which had been in contact with the substrate upon casting. Therefore, the Shigeru's film does not have such a high Gurley permeability as the present film, and a Gurley permeability of the Shigeru's film is 155 seconds/100cc (Shigeru's table 1).

Shigeru teaches in paragraph 0048 that:

In this invention, the aperture of a porous membrane and air permeability were measured by the following method.

** The scanning electron microscope photograph of the average pore size membrane surface of a porous membrane was taken, the punched surface product was measured about the opening of 50 or more points, and it asked for the average diameter at the time of presupposing that pore shape is a perfect circle according to a following formula from the average value of this punched surface product from calculation. Sa of a following formula means the average value of a punched surface product. Average pore size = it measured according to $2x(Sa/pi)^{1/2}$ ** air permeability JIS P8117. B type Gurley Denso meter (made by an Oriental energy machine company) was used as a measuring device. The film of a sample is bound tight to 28.6 mm in diameter, and the circular hole of area $^2$ of 645 mm. With the container liner weight of 567 g, the air in a pipe is passed out of a pipe from an examination circular hole part. Time for 100 cc of air to pass was measured, and it was considered as air permeability (Gurley value). ** The thickness, area, and weight of the film cut off in the void content predetermined size were measured, and the void content was calculated with the following formula from eyes weight. The weight in which S of the following formula measured the membrane area and thickness and w measured d, and D are polymer densities which form this porous membrane, for example, were set to 1.34 with aromatic polyimide.

Void content = (1-W/(SxdxD)) x100.

Shigeru further teaches in paragraph 0046 that:

The result of having sampled the polyimide porous membrane which carried out continuous fabrication succeedingly every 10 m, and having measured an average pore size and air permeability is shown in Table 1. Average value was [standard deviation of the aperture] 0.022 in 0.24 micrometer, and average value was [standard deviation of air permeability] 11.0 in 155 seconds/100cc. As for thickness, average value of standard deviation was 1.004 in 29.9 micrometers.

As shown above, an average pore size taught in Shigeru is measured on pores contained in only one side surface of the film which had not been in contact with the substrate upon casting

(air-side surface of the film), therefore, it is only taught in Shigeru that the Shigeru's film is homogeneous in the longitudinal direction of the film.

However, Shigeru does not teach the film being homogeneous as a whole, i.e., in the surface of the film which had not been in contact with the substrate upon casting, inside the film, and in the surface which had been in contact with the substrate upon casting.

Accordingly, if Shigeru's film has uniform micropores as a whole, i.e., in the surface of the film which had not been in contact with the substrate upon casting, inside the film, and in the surface which had been in contact with the substrate upon casting, it should show the high Gurley permeability as the present claimed film. The low Gurley permeability of Shigeru leads to a different and less average pore size inside the film, or in the surface which had been in contact with the substrate upon casting, or leads to a different and less continuity of the micropores, from one of the present film. The support for said presumption is based on the description in page 12, lines 13 to 15 in the present specification of: "The continuity of the micropores of the film can be indicated, for example, in terms of a Gurley permeability as a gas permeability and by a pure-water permeation rate."

Patel teaches in paragraph 0090 as follows;

**[0090]** A series of solutions were prepared of Butvar™ B-76 and GAF E735™ in mixtures of MEK and ethanol. The total solids content was kept constant (7.3 wt %), as was the ratio of hydrophobic polymer to hydrophilic polymer (2:1 by weight), but the relative proportions of MEK and ethanol were varied. The solutions were coated as in Example 1, dried 3 minutes at 60° C., and washed for 30 sec in distilled water at 15° C. The resulting coatings were then examined by SEM and the average pore size recorded:

However, Patel does not teach the film being homogeneous <u>as a whole</u>, i.e., in the surface of the film which had not been in contact with the substrate upon casting, inside the film, and <u>in the surface which had been in contact with the substrate upon casting</u>.

Patel does not teach: an average **surface** pore size A; an average **inside** pore size B; an average rate of **surface** hole area C; an average rate of **inside** hole area D; an average pore size $A^1$ at **one** surface; an average pore size $A^2$ at **the other** surface; an average rate of hole area $C^1$ at **one** surface; and an average rate of hole area $C^2$ at **the other** surface.

Therefore, Patel does not teach or suggest ratio of A/B, C/D, A1/A2, and C1/C2 at all.

Patel teaches *a porous film with a substrate* in paragraph 0041 as follows, and does not teach that the film is peeled from the substrate:

> [0041] In a typical procedure, the first polymer is dissolved in the aprotic organic solvent, the second polymer is dissolved in the alcohol, and the two solutions are mixed. Prior to coating on a suitable substrate, further quantities of one or both of the solvents may be added for final adjustment of the aprotic/hydroxylic ratio, or for adjustment of the solids content (and hence viscosity) of the coating solution. The substrate is typically a flexible, self-supporting sheet-form material such as resin-coated paper, aluminium foil or plastic film. A preferred substrate is polyester film of about 25-250 μm thickness. If necessary, it may comprise subbing layers, or be corona treated, to increase the adhesion of the coating. Alternatively, it may comprise a release layer to facilitate subsequent removal of the coating, if this is desired. The substrate may itself be microporous. For the purposes of this embodiment of the invention, a nonporous support (such as polyester film) bearing a microporous coating prepared by any method known in the art may be regarded as a microporous substrate. Image accepting members comprising a microporous organic polymer film on a microporous support of a particular defined type constitute a separate aspect of the invention, as described in greater detail hereinafter.

Therefore, Patel does not teach or suggest a porosity and an average pore size inside the film, and in the surface which had been in contact with the substrate upon casting, and meeting

the presently claimed property of a Gurley permeability. The presently claimed property of a Gurley permeability reflects the film having uniform micropores as a whole, i.e., in the surface of the film which had not been in contact with the substrate upon casting, inside the film, and in the surface which had been in contact with the substrate upon casting.

Additionally, Patel teaches the film produced by a method comprising a step of extraction in paragraphs 0021 to 0023 as follows:

> **[0021] (c) coating the resulting solution on a support;**
>
> **[0022] (d) effecting at least a partial drying of the resulting coating; and**
>
> **[0023] (e) washing the coating in an aqueous medium so as to extract at least 50% by weight of the said second polymer.**

On the other hand, in the present invention, the film is not extracted by an aqueous medium. Specifically, the present invention provides a method for producing a porous film without a support, including the steps of casting a polymer solution containing at least one polymer onto a substrate to form a film; and subjecting the film to phase conversion to thereby separate from the substrate and form a porous film, in which the polymer constituting the porous film has a surface tension Sa [mN/m], the substrate has a surface tension Sb [mN/m], and Sa and Sb satisfy the following condition: Sa-Sb≥-10 (page 2, line 21 to page 3, line 13 in the present specification).

Therefore, the method for producing a film of Patel differs from the method of the present invention, and it suggests that the films of Patel and present invention are structurally and compositionally **dis**similar.

While Patel discloses a microporous film (abstract) containing microscopic pores and voids wherein the pores and voids normally connect with each other and with at least one surface of the film (a large number of continuous micropores) (abstract and 0002), it is not clear that

Patel's film has uniform micropores as a whole, i.e., in the surface of the film which had not been in contact with the substrate upon casting, inside the film, and in the surface which had been in contact with the substrate upon casting as the film of the present invention.

Further, Patel teaches the step of drying of the coating, and that as a result of solvent evaporation, the coating solidifies in the form of a film, in paragraph 0043 as follows.

> **[0043]** The next step is drying of the coating. As a result of solvent evaporation, the coating solidifies in the form of a film which appears clear and homogeneous to the naked eye. However, subsequent aqueous extractive treatment reveals it to be phase-separated on a microscopic scale. It is not clear whether the phase separation takes place during the drying process or at an earlier stage, but both these mechanisms are within the scope of the invention. In the practice of the invention, drying must proceed at least to the point at which the coating solidifies, but it is not necessary to remove all traces of solvent before the washing step, especially if washing is carried out in-line, in which case there is less risk of physically damaging the coating while it remains relatively soft.

On the other hand, in the present invention, the film is produced by a method including the steps of casting a polymer solution containing at least one polymer onto a substrate to form a film; and subjecting the film to phase conversion to thereby separate from the substrate and form a porous film.

Therefore, it is considered again that Patel's film is produced by a different method from the present invention.

Accordingly, Patel does not disclose or suggest the present object which is to prevent the resulting film produced by the phase conversion technique using the polymeric compound as a material, from having a skin layer (compact layer) on its surface and from containing substantially no hole area (opening) or contains some openings with a low rate of hole area.

Based on the foregoing, the inventive film is structurally distinct from the film of Patel, and as such, significant patentable distinctions exist between the teachings of Patel and the presently claimed invention. In conclusion, withdrawal of Rejection (B) is respectfully requested.

Applicants now turn to Rejection (C).

Masayuki teaches in paragraphs 0009 to 0010 that

> " ... and the thin film in which polyamic acid is still more liquefied in an imide-ized agent content non solvent, It deposits imide-izing and the method of heating the obtained imide film, etc. are known. After casting into film state the polyamic acid which dissolved into the solvent, the method of making a non solvent contact and inducing a phase separation deposit of polyamic acid is known. The gas separation membrane by these manufacturing methods turns into a porous membrane which has ***the uneven structure*** to which ***the dense layer was formed in at least one [in contact with a non solvent] field***, and the hole (several micrometers - tens of micrometers) existed in the inside of a film. Although the dense layer formed in the film surface reveals the separability of gas, when such a gas separation membrane is used as a separator for cells, this dense layer serves as a barrier which checks the charge and discharge of a cell. The hole which furthermore exists in the inside of the film of a gas separation membrane -- ***structure is a closed cell rather in many cases rather than penetrates to the cross sectioned direction of a film, and there is a problem also from a viewpoint of the infiltration required of the separator for cells***". (Emphasis added).

Masayuki further teaches in paragraph 0012 that:

> "This invention prepares a solution which consists of 0.3 to 60 % of the weight of polyimide precursors, and 99.7 to 40 % of the weight of solvents, Said solution is cast into film state, and by making a coagulation solvent contact ***via solvent substitution speed-regulation material***, a polyimide precursor is related with a manufacturing method of a polyimide porous film carrying out [heat treatment or] a chemical treatment in this polyimide precursor porosity film, after porosity-izing, a deposit". (Emphasis added).

As disclosed in page 2, lines 4 to 12 in the present specification, porous films using a polyimide, a kind of imide polymer, as a material and production thereof, and produced ***using a control member for a solvent replacement rate***, thereby require **complicated production processes** and have **insufficient rates of hole area and permeability**. As a result of the insufficient rates of hole area and permeability, Masayuki's film has low air permeability 30 seconds/100cc - 2000 seconds/100cc.

On the other hand, in the present invention, the film is produced with the substrate having a surface tension Sb [mN/m], and Sb and Sa [mN/m] (Sa: a surface tension of the polymer constituting the porous film) satisfying the following condition: $Sa\text{-}Sb \geq -10$, and is made without ***solvent substitution speed-regulation material*** of Masayuki. **The present surface tension limitation for the substrate** is not taught or suggested in Masayuki. Then, the present film may be produced without the complicated production processes, and has the presently claimed high property of a Gurley permeability of 0.2 second/100cc - 29 seconds/100cc.

Accordingly, if for arguments sake, it is considered that the disclosure of Masayuki meets the claim requirement of ratio of A/B, C/D, $A^1/A^2$, and $C^1/C^2$ of 1, since the porous film of Masayuki and that of the present invention are structurally dissimilar, the presently claimed property of Gurley permeability should not be present.

Based on the foregoing, the inventive film is structurally distinct from the film of Masayuki, and as such, significant patentable distinctions exist between the teachings of Masayuki and the presently claimed invention. In conclusion, withdrawal of Rejection (C) is respectfully requested.

***Process claims 1-3***

The presently claimed film produced by the process of claim 1 has advantageously property of Gurley permeability, and is patentable.

Therefore, the processes of currently pending claims 1 to 3 are also patentable and should be allowed.

Should there be any outstanding matters that need to be resolved in the present application, the Examiner is respectfully requested to contact Craig A. McRobbie, Reg. No. 42,874 at the telephone number of the undersigned below, to conduct an interview in an effort to expedite prosecution in connection with the present application.

If necessary, the Commissioner is hereby authorized in this, concurrent, and future replies to charge payment or credit any overpayment to Deposit Account No. 02-2448 for any additional fees required under 37.C.F.R. §§ 1.16 or 1.14; particularly, extension of time fees.

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Respectfully submitted,

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Attached: Shigeru et al., JP 2002-086476 - machine English translation thereof